

Function







eGRID performs a full steady state calculation of radial electrical grid systems. For design, optimisation and documentation of the grid connection of both a single wind turbine generator (WTG) as well as several groups of wind farms. eGRID can also calculate a traditional grid without any WTGs. The graphical user input of lines that “snap” to WTGs, transformers or loads sets new standards for graphic design of electrical grids. The calculation results can be checked according to different norms, standards and guidelines. This happens very flexible according to local and country-specific built-in demands and regulations.

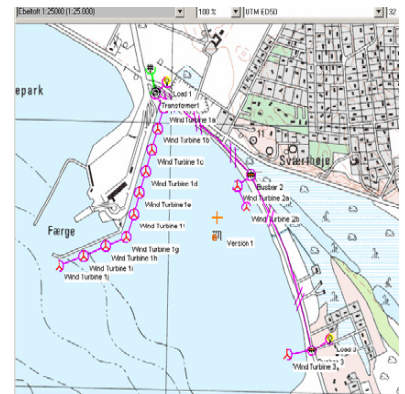
Calculation model

The calculations are based on two engines: *Load Flow* and *Short circuit* both developed by University of Kassel, Germany within the frame of the EU financed DISPOWER project (2002-05).

Necessary Input Data (objects)

Please note that the objects are entered in the WindPRO module BASIS, where objects are put directly on a map and properties applied. Besides WTG objects, these are the **new objects for eGRID**:

-  External Grid (also used for the specification of all voltage levels)
-  Transformer
-  Loads / Compensation units
-  Busbars (for connecting cables/lines of different types or connecting more cables/lines of same type in Y or star point)
-  Electric Grid (like a “line object”, used for drawing overhead lines / cables on the map – these can automatically “snap” to objects)
-  Additionally, WTGs in the WTG catalogue can be expanded with their electrical properties, like generator parameters, built in transformers etc.



Description

eGRID covers the most specific tasks needed for calculation of WTG grid integration:

- Annual losses in cables and transformers based on local wind climate
- Check of the cable and transformer design (load in percentage of capacity)
- Steady state voltage variations based on two free-definable load situations or auto-defined (from Norm)
- Short circuit power and current
- Voltage fluctuations (long-term flicker)
- Voltage variations caused by switching effects
- Verification of the calculated values with determined demands given by e.g. the utility
- List of cables and components used for cost calculations, including both cable length and excavation length, taking topography and gradients into account.

The user can easily calculate the complex structure for e.g. several wind farms or offshore farms in a large grid area. Special electro-technical knowledge is not required. Even if you “only” require a software tool for just the calculation of expected annual electrical losses for a wind farm, the eGRID module is the right choice as this part is typically not included in other grid calculation tools, and the reports are easy to read for investors.

Calculation reports

The report generator offers the following reports:

- Assumptions
- Losses
- Design check
- Voltage variations
- Short circuit
- Long term Flicker
- Voltage variations due to switching effects
- List of electrical components

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Project: Immenhausen with transformers EMD Deutschland Ludwig-Erhard-Strasse 10 34131 Kassel / Germany	Description: Standort "Alte Schanze" Gemeinde Immenhausen, Landkreis Kassel, Bundesland Hessen	Printed/Page: 27-04-2005 13:37 / 1 Licensed user: EMD International A/S Niels Jernesvej 10 DK-9220 Aalborg Ø +96 35 44 44 Calculated: 27-04-2005 13:37/2.5.0.33
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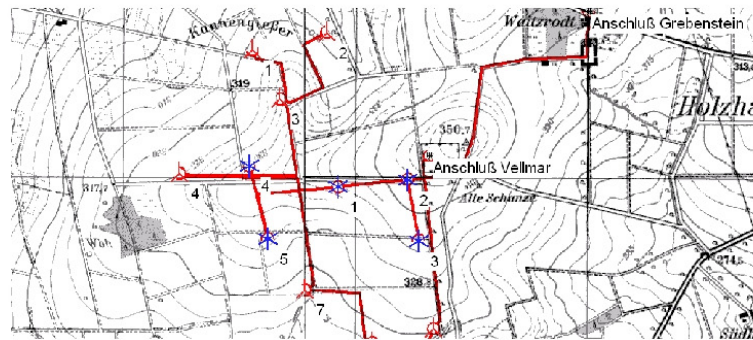
eGrid - Project data overview

External grid

Name : Anschluß Vellmar
 Short circuit power : 105,5 MVA
 Phase angle : 64,80 °
 Voltage level : 20,00 kV
 Frequency : 50 Hz

Voltage levels in project

Name	Nominal voltage [kV]
20kV	20,00
0,69kV	0,69



Scale 1:25000
 ▲ New WTG ★ Existing WTG ⊙ Transformer(t) † External grid

Transformers

Description	GK (Bessel) Zone: 3			Rated power [MVA]	High voltage [V]	Low voltage [V]	File name
	East	North	Z				
WKA 5 - NM 48-750 Transformer	3.534.785	5.697.520	0	0,8	20,00	0,00	Pauwels_Oil_AC-20Windkraft_0.8_0.69_20_50.TRAFO
WKA 6 - NM 48-750 Transformer	3.535.076	5.697.293	0	0,8	20,00	0,00	Pauwels_Oil_AC-20Windkraft_0.8_0.69_20_50.TRAFO
WKA 7 - VW-520 750 Transformer	3.535.340	5.697.356	0	0,8	20,00	0,00	Pauwels_Oil_AC-20Windkraft_0.8_0.69_20_50.TRAFO
WKA 4 - NM 60-1000 Transformer	3.534.240	5.698.012	0	1,3	20,00	0,00	Pauwels_Oil_AC-20Windkraft_1.25_0.69_20_50.TRAFO
WKA 2 - NM 60-1000 Transformer	3.534.875	5.698.615	0	1,3	20,00	0,00	Pauwels_Oil_AC-20Windkraft_1.25_0.69_20_50.TRAFO
WKA 1 - NM 60-1000 Transformer	3.534.555	5.698.540	0	1,3	20,00	0,00	Pauwels_Oil_AC-20Windkraft_1.25_0.69_20_50.TRAFO
WKA 3 - VW-520 750 Transformer	3.534.675	5.698.331	0	0,8	20,00	0,00	Pauwels_Oil_AC-20Windkraft_0.8_0.69_20_50.TRAFO

WTGs

Description	GK (Bessel) Zone: 3			Rated power [kW]	Cos phi	Voltage [kV]	Generator type	Built in transformer
	East	North	Z					
1 WKA 1 - N...	3.534.555	5.698.540	320	1.000	Load dependend	0,69	Induction	Pauwels_Oil_AC-20Windkraft_1.25_0.69_20_50.TRAFO
2 WKA 2 - N...	3.534.875	5.698.615	320	1.000	Load dependend	0,69	Induction	Pauwels_Oil_AC-20Windkraft_1.25_0.69_20_50.TRAFO
3 WKA 3 - W...	3.534.675	5.698.331	327	750	Load dependend	0,69	Induction	Pauwels_Oil_AC-20Windkraft_0.8_0.69_20_50.TRAFO
4 WKA 4 - N...	3.534.240	5.698.012	323	1.000	Load dependend	0,69	Induction	Pauwels_Oil_AC-20Windkraft_1.25_0.69_20_50.TRAFO
5 WKA 6 - N...	3.535.076	5.697.293	316	750	Load dependend	0,69	Induction	Pauwels_Oil_AC-20Windkraft_0.8_0.69_20_50.TRAFO
6 WKA 7 - W...	3.535.340	5.697.356	321	750	Load dependend	0,69	Induction	Pauwels_Oil_AC-20Windkraft_0.8_0.69_20_50.TRAFO
7 WKA 5 - N...	3.534.785	5.697.520	319	750	Load dependend	0,69	Induction	Pauwels_Oil_AC-20Windkraft_0.8_0.69_20_50.TRAFO

Lines

From	To	Length [m]	Type	Material	Cross section [mm ²]	Limit factor
cA WKA 5 - NM 48-750 Transformer <HIGH>	WKA 4 - NM 60-1000 Transformer <HIGH>	1.018	Cable	Al	185	0,81
cB WKA 3 - VW-520 750 Transformer <HIGH>	WKA 2 - NM 60-1000 Transformer <HIGH>	518	Cable	Al	185	0,81
cC WKA 6 - NM 48-750 Transformer <HIGH>	WKA 5 - NM 48-750 Transformer <HIGH>	472	Cable	Al	185	0,81
cD WKA 4 - NM 60-1000 Transformer <HIGH>	WKA 3 - VW-520 750 Transformer <HIGH>	849	Cable	Al	185	0,81
cE Anschluß Vellmar	WKA 7 - VW-520 750 Transformer <HIGH>	766	Cable	Al	185	0,81
cF WKA 7 - VW-520 750 Transformer <HIGH>	WKA 6 - NM 48-750 Transformer <HIGH>	302	Cable	Al	185	0,81
cG WKA 3 - VW-520 750 Transformer <HIGH>	WKA 1 - NM 60-1000 Transformer <HIGH>	322	Cable	Al	185	0,81

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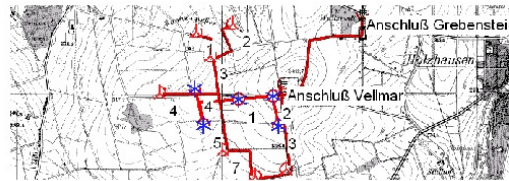
eGrid - Design check

Assumptions

Fixed voltage node: Anschluß Vellmar
 Fixed voltage: 20,00 kV

Allowable voltage difference

Level	Nominal voltage [kV]	Contracted voltage [kV]	Max above [%]	Max below [%]
20kV	20,00	20,00	10,0	10,0
0,69kV	0,69	0,69	10,0	15,0



WTG power

WTG power used in calculation: Rated power

WTG	Input		Result			
	P [MW]	Cos Phi	Scale factor	P [MW]	Q [MVar]	Cos Phi
1 WKA 1 - NM 60-1000	1,00	0,9800	1,00	1,00	-0,20	0,9800
2 WKA 2 - NM 60-1000	1,00	0,9800	1,00	1,00	-0,20	0,9800
3 WKA 3 - W-520 750	0,75	0,9800	1,00	0,75	-0,15	0,9800
4 WKA 4 - NM 60-1000	1,00	0,9800	1,00	1,00	-0,20	0,9800
5 WKA 6 - NM 48-750	0,75	0,9800	1,00	0,75	-0,15	0,9800
6 WKA 7 - W-520 750	0,75	0,9800	1,00	0,75	-0,15	0,9800
7 WKA 5 - NM 48-750	0,75	0,9800	1,00	0,75	-0,15	0,9800

No loads in calculation

Calculation results

Voltages

Node	U [kV]	Angle [°]	Contracted voltage [kV]	Max above [%]	Max below [%]	DU [%]	Assessment
Far Generator	19,80	0,00	20,00	10,0	10,0	-0,9911	ok
Anschluß Vellmar	20,00	3,27	20,00	10,0	10,0	0,0000	ok
WKA 7 - W-520 750 Transformer <HIGH>	20,03	3,37	20,00	10,0	10,0	0,1535	ok
WKA 7 - W-520 750 Transformer <LOW>	0,69	-143,34	0,69	10,0	10,0	-0,1522	ok
WKA 6 - NM 48-750 Transformer <HIGH>	20,04	3,40	20,00	10,0	10,0	0,2065	ok
WKA 6 - NM 48-750 Transformer <LOW>	0,69	-143,31	0,69	10,0	10,0	-0,0989	ok
WKA 5 - NM 48-750 Transformer <HIGH>	20,06	3,45	20,00	10,0	10,0	0,2776	ok
WKA 5 - NM 48-750 Transformer <LOW>	0,69	-143,27	0,69	10,0	10,0	-0,0274	ok
WKA 4 - NM 60-1000 Transformer <HIGH>	20,08	3,53	20,00	10,0	10,0	0,4057	ok
WKA 4 - NM 60-1000 Transformer <LOW>	0,69	-143,88	0,69	10,0	10,0	0,1827	ok
WKA 3 - W-520 750 Transformer <HIGH>	20,10	3,59	20,00	10,0	10,0	0,4838	ok
WKA 3 - W-520 750 Transformer <LOW>	0,69	-143,15	0,69	10,0	10,0	0,1801	ok
WKA 2 - NM 60-1000 Transformer <HIGH>	20,10	3,60	20,00	10,0	10,0	0,5011	ok
WKA 2 - NM 60-1000 Transformer <LOW>	0,69	-143,62	0,69	10,0	10,0	0,2786	ok
WKA 1 - NM 60-1000 Transformer <HIGH>	20,10	3,59	20,00	10,0	10,0	0,4945	ok
WKA 1 - NM 60-1000 Transformer <LOW>	0,69	-143,82	0,69	10,0	10,0	0,2720	ok

Utilisation check

Transformer:	Connector	Node out	Node in	Sout [MW]	Sin [MW]	Rated [MVA]	Load [%]	Assessment
0,8MVA-20,0/0,7kV	WKA 7 - W-520 750 Transformer <HIGH>	WKA 7 - W-520 750 Transformer <LOW>	WKA 7 - W-520 750 Transformer <LOW>	0,77	0,77	0,80	95,9	Ok
0,8MVA-20,0/0,7kV	WKA 6 - NM 48-750 Transformer <HIGH>	WKA 6 - NM 48-750 Transformer <LOW>	WKA 6 - NM 48-750 Transformer <LOW>	0,77	0,77	0,80	95,9	Ok
0,8MVA-20,0/0,7kV	WKA 5 - NM 48-750 Transformer <HIGH>	WKA 5 - NM 48-750 Transformer <LOW>	WKA 5 - NM 48-750 Transformer <LOW>	0,77	0,77	0,80	95,9	Ok
1,3MVA-20,0/0,7kV	WKA 4 - NM 60-1000 Transformer <HIGH>	WKA 4 - NM 60-1000 Transformer <LOW>	WKA 4 - NM 60-1000 Transformer <LOW>	1,02	1,02	1,25	81,8	Ok
0,8MVA-20,0/0,7kV	WKA 3 - W-520 750 Transformer <HIGH>	WKA 3 - W-520 750 Transformer <LOW>	WKA 3 - W-520 750 Transformer <LOW>	0,77	0,77	0,80	95,9	Ok
1,3MVA-20,0/0,7kV	WKA 2 - NM 60-1000 Transformer <HIGH>	WKA 2 - NM 60-1000 Transformer <LOW>	WKA 2 - NM 60-1000 Transformer <LOW>	1,02	1,02	1,25	81,8	Ok
1,3MVA-20,0/0,7kV	WKA 1 - NM 60-1000 Transformer <HIGH>	WKA 1 - NM 60-1000 Transformer <LOW>	WKA 1 - NM 60-1000 Transformer <LOW>	1,02	1,02	1,25	81,8	Ok

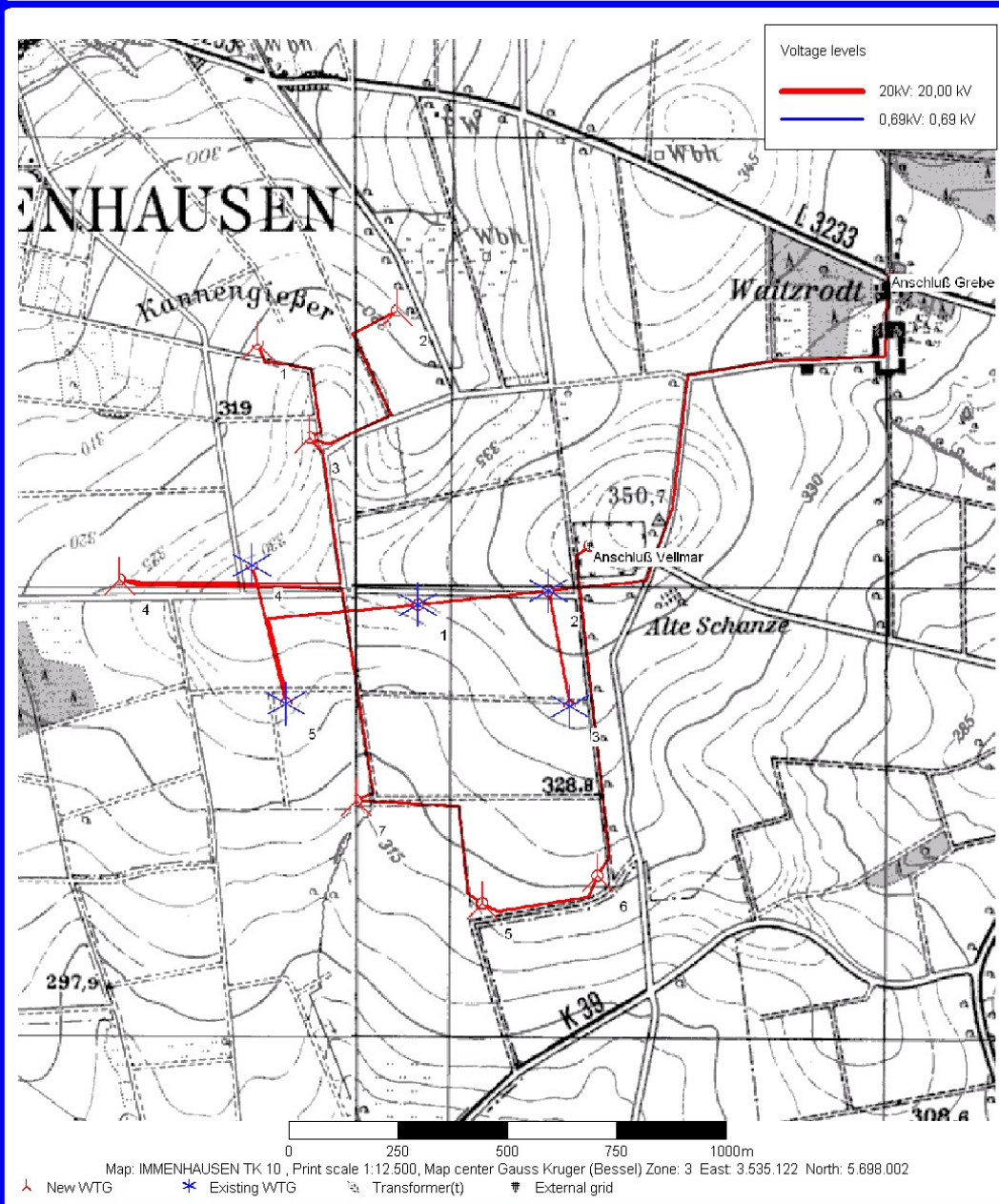
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eGrid - IMMENHAUSEN TK 10

File: Immenhausen TK 10.bmi



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